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Analyzing the Development of Russia's Agricultural Sector to Identify Import Needs and Product Range

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Under the sanctions, Russian agricultural producers face challenges related to the differing degrees of dependency of agricultural sectors on imports. This article identifies the agro-industrial sectors that are most dependent on imported products. Using statistical methods and qualitative content analysis of the corresponding scientific literature, the authors summarize research results on the share of imports in the Russian agro-industrial complex. The study identifies the agricultural sectors most dependent on imports. Particularly in vegetable and fruit cultivation, sectors like tomato and cucumber farming are highly import-dependent due to limited domestic production capabilities. The authors emphasize that import dependency should not be measured solely by the availability of certain agricultural products on the Russian market. It is also essential to consider the share of imports in the seeds and eggs required for production, animal feed, and agricultural machinery. Seeds emerge as the most problematic area. However, the authors note the positive impact of Russian policies aimed at reducing import dependency, particularly regarding the provision of hatching eggs. Dependency in this area has decreased by 90% due to efforts by the Ministry of Agriculture of the Russian Federation. In conclusion, after highlighting the most import-dependent areas, the authors stress the importance of investing in these sectors. To mitigate these dependencies, policy recommendations include enhancing domestic seed production, increasing investment in local agricultural technologies, and strengthening public-private partnerships to boost local production capacities.

Keywords: Agri. food sector, agricultural trade, market analysis, import policy, international corporations.

INTRODUCTION

The modern development of the agricultural sector is characterized by significant dependence on global production chains and external innovative solutions (Abadi *et al.*, 2024; Hai-Dang-Nguyen *et al.*, 2024). This has created a new economic reality for the Russian agro-industrial complex, where not only domestic resources and potential play a key role but also the ability to adapt to changing global trends (Chowhan *et al.*, 2023). On the contrary, increasing sanctions and restrictions imposed by certain countries have heightened the need to find new development paths for Russia's agricultural sector. Under these conditions, it becomes important to strengthen domestic scientific and production potential, develop measures for adaptation, and seek alternative markets and sources of investment.

The Russian agricultural sector has been on the incline since 1999, marking its reemergence as a lead exporter of wheat and vegetable oil, accounting for about 20% of international wheat exports and a 55% increase in gross agricultural output between 1999 and 2017 (Uzun *et al.*, 2019). However, this progress is uneven across the agricultural spectrum, with significant vulnerabilities in areas such as vegetable and fruit cultivation, seed production, and agricultural machinery.

Due to the implementation of the food import substitution in 2014, imports stabilized and decreased while exports increased. A record 20% decrease in imports was recorded between 2013 and 2017 (Uzun *et al.*, 2019). Although this policy could be considered a success, the import dependence on seed materials still remains at a high level. In 2018, about $637 million worth of seeds were imported into Russia. These seeds were comprised of sunflowers (46%), corn seeds (24%),

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sugar beets (15%), and vegetable seeds (13%) (Maslova *et al.*, 2019).

This dependence is not limited to only seeds, as statistics show that the major composition of imported agricultural products, in addition to seeds, includes animal feed, poultry, pig farming, and agricultural machinery. In 2018, imported purebred farm animals were estimated at $208 million US, consisting mainly of cattle (78%), pigs (6%), and poultry (12%) (Maslova *et al.*, 2019). Recent research shows that between 2015 and 2021, there has been an increase in the import of purebred breeding pigs but a gradual reduction and stabilization in the import of bovine serum and a gradual increase in the local production of bovine semen using old stock (Zemlyakova, 2023).

The import of breeding materials such as hatching eggs and bull sperm recorded in 2018 amounted to about $250 million. A high percentage of import dependence was observed in chemical plant protection products. Studies show that with a production of about 67,600 tons per year, Russia imported about 63,000 tons (Maslova *et al.*, 2019). Recent studies show that Russian companies tend to import active ingredients and most of the conformulants, and there was a significant increase in Chinese suppliers share from 61.8% to 85.3% after the introduction of sanctions (Zhilkin and Grigoryev, 2023).

Modernizing and developing the agro-industrial complex requires access to advanced machinery and equipment. Russian manufacturers currently lack the capacity to meet the demand for high-tech agricultural equipment, resulting in a reliance on imports from countries like Germany, the Netherlands, and the United States (Turishcheva *et al*., 2020; Komissarova *et al*., 2020; Tolmachev *et al*., 2020). In addition to the above, Russia significantly imports agricultural machinery, mostly mowers, with yearly estimates of over $500 million (Maslova *et al.*, 2019; Semenenko *et al.*, 2020).

The international trade in the former Soviet Union has been discussed by Izmailova (2021), Kovtun (2019), Melanina (2018), Melnik (2020), Mirakyan (2020), Ozhigina (2018) and Tkach (2019).

Other scholars whose works on international trade between Russia and the post-Soviet countries were used as the basis for this study include Petrov (2020), Narbut (2021) andTsypin (2021).

Other significant studies dedicated to expanding international cooperation include the works by Kavitha *et al*. (2021), Petrov (2020), Sigidov (2021), Poltarykhin *et al*. (2021), Rozhnova *et al*. (2019), Fedotova *et al*. (2020), Gavel *et al*. (2018), Savkina *et al*. (2020), Shnaider *et al*. (2020) and Sembiyeva *et al*. (2020).

The Russian agricultural sector has long been affected by its dependency on imported products, particularly in the context of economic sanctions (Muzalev *et al*., 2023; Akulich *et al*., 2021; Barilenko *et al*., 2019). As these sanctions continue to impact agricultural production, it becomes critical to identify and assess the sectors most vulnerable to import reliance (Gnezdova *et al*., 2018; Chernysheva *et al*., 2019; Gorodetskaya *et al*., 2020). To explore these dependencies, the research employs a combination of statistical methods and qualitative content analysis (Efimova, 2018; Shabbir *et al*., 2021; Igibayeva *et al*., 2020). Specifically, data on the share of imports in key sectors will be analyzed to quantify the extent of dependency. In addition, a review of the relevant scientific literature will provide insights into the trends, challenges, and potential solutions related to import dependency.

MATERIALS AND METHODS

***Literature Search and Selection Criteria*:** The foundation of the study was formed by the scientific works of leading Russian specialists in statistics, analysis, and the development of Russia's agricultural sector. The methodological basis of the article relies on statistical methods and qualitative content analysis of scientific literature.

The article is of a review nature and primarily draws upon scientific articles and monographs on relevant topics. To select the sources, we employed the PRISMA algorithm. At the first stage, we searched for scientific materials using the following keywords in article titles: Russian agro-complex, Russian agriculture, Russian food industry, agricultural market, and Russian agro-industrial complex. This search yielded approximately 100 scientific works on the topic. At the second stage, the abstracts of the selected articles were analyzed to filter out works unrelated to the research topic. After this step, 85 articles remained. In the third stage, a full-text analysis of the articles was performed to ensure complete alignment with the study's focus. Following this step, 65 articles were included in the final research sample.

***Databases Consulted*:** A thorough literature search was conducted using several academic databases. The primary sources consulted included PubMed, Web of Science, Google Scholar, and Research Gate, which provided a comprehensive selection of relevant studies and publications.

***Criteria Applied*:** To fully understand the dependency of the agricultural sector on foreign supplies, it is essential to consider this dependency in two key aspects: product-based and technology-based. Special attention was paid to issues such as technological gaps, policy constraints, and trade barriers that hindered the growth of domestic production. The analysis also identified recurring policy recommendations from experts and industry leaders, which helped inform the study's policy suggestions.

The product-based aspect of import dependency relates to reliance on imported food products for final consumer distribution. Despite significant efforts to develop and support the Russian agro-food complex, the domestic market still experiences a need for foreign products in some categories. This is influenced by various factors, including climate,

Table 1. Level of self-sufficiency in basic food products, % based on (Federal State Statistics Service, 2023).

Product	2015	2018	2019	2020	2021	2022
Grain	149.1	147.2	155.6	165.6	148.3	191.4
Meat	88.7	95.7	97.4	100.1	99.7	101.8
Milk	79.9	83.9	83.9	84.0	84.3	85.7
Eggs	98.2	97.7	97.1	97.4	98.2	98.0
Fish	132.8	158.5	152.8	160.7	153.7	165.3
Potatoes	102.1	95.3	95.1	89.2	88.7	94.5
Vegetables and melons	86.8	87.2	87.7	86.3	86.5	88.5
Fruits and berries	32.5	38.8	40.2	42.4	44.4	47.3
Sugar	100.6	109.5	126.8	99.9	100.5	101.6
Table salt	68.5	67.3	63.8	65.7	68.5	64.2
Vegetable oil	125.5	157.4	179.1	200.0	182.0	192.6

Values exceeding 100% indicate overproduction and export potential, while values below 100% signify the need for imports to meet domestic demand.

consumer preferences, and the technological capabilities of local production (Abdullaev *et al.*, 2024; Kutz *et al.*, 2024).

RESULTS

Let us present the level of self-sufficiency in Table 1, indicating the consumption volume covered by Russian production.

Grain crops, fish, and vegetable oil demonstrate a significant surplus relative to domestic market needs, reflecting a high degree of self-sufficiency and even export potential. This is particularly evident in 2022, with self-sufficiency levels reaching 191.4, 165.3, and 192.6%, respectively.

In the meat production sector, there is a positive trend in the growth of self-sufficiency levels, surpassing the 100% threshold in 2020, indicating the achievement of self-reliance and a reduction in import dependency by 2022. Sugar production consistently demonstrates self-sufficiency year after year. The situation with milk and dairy products shows steady, albeit modest, growth in self-sufficiency. However, it has not reached the 100% threshold, indicating a continued, though gradually decreasing, reliance on imports.

The Russian production of eggs, potatoes, and vegetables, including food-grade melons, largely meets domestic demand. However, self-sufficiency levels throughout the period remain below 100%, indicating a slight dependence on imports. Fruits and berries are the most import-dependent category (Makarova *et al.*, 2022; Antonenko and Zubkov, 2024), with self-sufficiency levels significantly below 50%. This highlights a critical need for imports to support the Russian market. Similarly, table salt production lacks self-sufficiency, revealing continued import dependence despite some growth in domestic production.

The technological aspect of import dependency entails the reliance of the agricultural sector not only on imported final agricultural products but also on production inputs such as seeds, agricultural machinery and equipment, technologies, fertilizers, and plant protection products (Altynay *et al.*, 2023; Antonenko *et al.*, 2024). This aspect of dependency requires special attention as technological support directly influences productivity levels, product quality and safety, and the ecological sustainability of production (Korotenko and Togusakov, 2024; Naliukhin *et al.*, 2024).

Regarding the dependency of the agro-industrial complex on imported seeds, there is significant variation depending on the specific crop. Data on the share of Russian and imported seeds are presented in Figure 1.

According to Figure 1, dependence on imported crop seeds differs for different crops. Three main groups can be distinguished, based on the ratio of Russian and foreign seeds in the total volume for each crop.

The first group is characterized by the predominance of Russian seeds. This group includes winter wheat, spring wheat, and spring barley, where the share of Russian seeds is 92.2, 77.4, and 70.1%, respectively. The performance of these crops indicates the strong position of Russian breeding and minimal dependence on external suppliers.

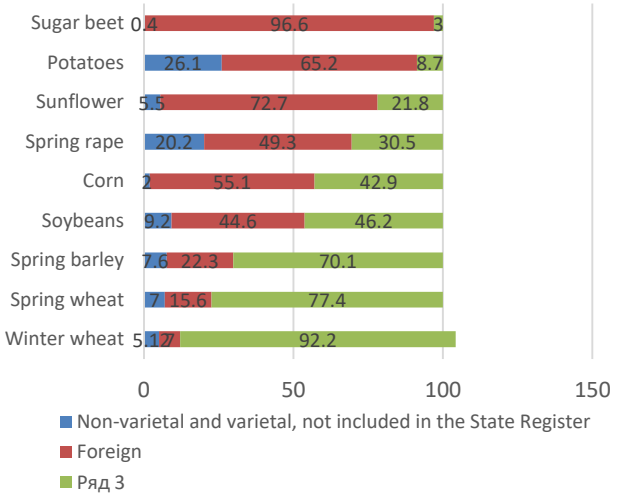

Figure 1. The share of Russian and imported seeds in the total volume of seeds in 2022 (based on materials from (Maksimova, 2022).

In the second group, there is almost a balance between the shares of Russian and foreign seeds. It includes soybean and corn with the shares of Russian seeds at 46.2 and 42.9% against 44.6 and 55.1% of foreign seeds, respectively. This indicates moderate import dependence and a significant potential for Russian breeding to increase its market share.

The third group shows a high level of dependence on foreign seed supplies. This category includes spring rape, sunflower, and potato with the shares of foreign seed 49.3, 72.7, and 65.2%, respectively. This situation emphasizes the predominance of foreign breeding and reflects the need to strengthen Russian breeding efforts to reduce import dependence (Gasparyan *et al.*, 2024).

Sugar beet is an exception, showing a huge 96.6% dominance of foreign seed, making this crop almost completely dependent on external suppliers.

The livestock industry in Russia is significantly import-dependent, primarily in terms of genetic resources. This dependence can be seen in several main directions: imports of semen products, embryos, hatching eggs, and pedigree and marketable young stock. The reason for this dependence is the need to improve the genetic potential of the Russian livestock population and increase productivity and product quality. Imported genetic materials allow efficient breeding and selection, introducing valuable genetic lines and achieving improved breed characteristics of livestock and birds (Mahmood *et al.*, 2022; Sivkova and Domatskiy, 2023; Suarsa *et al.*, 2024).

Until recently, a critical situation in terms of dependence on imports was observed in the poultry industry. In 2021, the share of imports of hatching eggs of broiler chicken reached 98.7%, turkey breeding grew to 100%, and egg poultry farming amounted to 75.0%. However, "support of the Ministry of Agriculture of the Russian Federation in the form of compensation of part of direct costs for the creation of first- and second-order reproducers and preferential investment loans for the purchase of machinery and equipment and construction and reconstruction of poultry farms were able to significantly improve the situation" (Federal State Budgetary Institution Center for Agroanalytics, 2024). At the beginning of 2023, the share of Russian hatching eggs amounted to almost 90%, and this upward trend has continued until now (Shokurova, 2023).

In relation to pig breeding in Russia, "this area has reduced its dependence on imported breeding animals quite significantly due to the recently developed network of breeding and genetic centers" (Tikhomirov and Fomin, 2023).

However, there is a rather high dependence on specialized IT products. Most of the advanced software for smart pig breeding technologies is foreign. In rare cases, these are localized solutions based on imported software. Their import substitution is low, and Russian software is used in the industry only for management accounting (Smirnova, 2022).

In terms of beef cattle resources, scientists and specialists mention a noticeable tendency of decrease in the number of Russian meat breeds due to a high share of foreign genetic materials, which is associated with better product quality of the latter: "At the same time, import substitution is not possible at the moment because breeding with Russian and foreign breeds has only recently begun, and its own breeding base of beef cattle breeds has not been created yet" (Ulimbashev *et al.*, 2023).

For imports of pedigree young stock of dairy cattle breeds, there is a trend towards technological independence, but the share of imports is still quite high. In 2022, the share of imports amounted to 24% of the Russian market volume, if compared to 35% in 2021 (Obyasnyaem, 2023). More than 90% of these imports are Holstein cattle of predominantly Danish, German, and Dutch breeding (Ulimbashev *et al.*, 2023).

The high share of imported young stock of dairy breeds is conditioned by the lack of stock in Russia due to low reproduction and short periods of production use. Cattle breeders try to solve this problem by reproduction through the seed of producer bulls, but the share of imports is extremely high in this area, i.e., about 40% (Government of the Russian Federation. Strategy for the development of the agro-industrial and fisheries complexes of the Russian Federation until 2030, 2023).

There is also serious dependence on imports in the production of feed for livestock, namely the shortage of additives, feed proteins, amino acids, etc. (Korotkiy *et al.*, 2024). Table 2 presents data on the share of imports for feed components, including the share of imports from "unfriendly" countries.

Table 2. Import shares of different animal feed components (based on materials from Kabanova (2023).

Component	Share of imports in consumption, %	Share of imports by "unfriendly" countries, %
Methionine	65	91
Arginine	100	88
Microbial feed protein	70	82
Valine, tryptophan	100	28
Choline chloride feed (vitamin B4)	100	21
Threonine	100	5
Lysine	40	1

As can be seen in Table 1, feed additive choline chloride and amino acids (arginine, valine, threonine, and lysine) are imported in full volume. From a risk perspective, microbial protein and amino acids (methionine and arginine)

(Tkeshelashvili and Bobozhonova, 2024) are almost entirely imported from "unfriendly" countries such as Belgium, France, and Japan.

The final area of agriculture where import dependence should be analyzed is agricultural machinery. The data on the shares of Russian and imported agricultural machinery are presented in Figure 2.

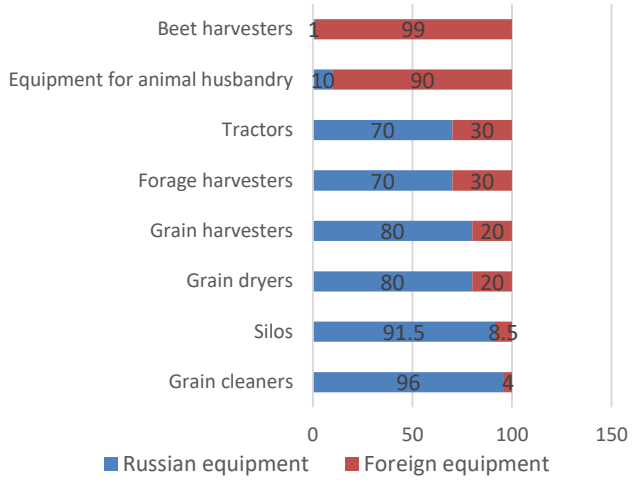

Figure 2. The share of Russian and imported equipment in the agro-industrial complex of the Russian Federation (based on materials from Tikhomirov and Fomin (2023).

The analysis of Figure 2 shows a high degree of import dependency in specific areas of Russia's agro-industrial complex. This dependency is particularly pronounced in sugar beet harvesters, where foreign equipment accounts for 99% of the market. Significant reliance on imported equipment is also observed in livestock machinery, with imports making up 90% of this sector.

In contrast, tractor and forage harvesting equipment, grain harvesters, grain dryers, silos, and grain cleaners show relatively low import dependency. In these categories, the share of domestically produced equipment ranges from 70 to 96%, demonstrating the substantial contribution of local production and the potential for reducing external dependencies.

DISCUSSION

Our results from this study highlight significant progress towards self-sufficiency, particularly in grain, meat, sugar, and vegetable oil production. These results align with recent literature highlighting Russia's effort on reducing import dependency and increasing self-sufficiency (Chernova *et al.*, 2020). Our results also show a steady trend in the overproduction of grains and vegetable oil for the last seven years. These results are consistent with the works of (Melnikov *et al.*, 2020; Tumanyan and Shcherbakov, 2020).

The livestock industry expressed as meat and milk in our result remains dependent on the import of genetic materials, breeding materials, and vaccines. This development calls for a focus on import substitution policies as addressed in recent research. Our opinion agrees with (Chernova *et al.*, 2020) and (Yahina *et al.*, 2023), who highlight the need for the development of sectoral measures and the optimization of import substitution, citing case studies from Miratorg LLC and LLC Skvortsovo. Recent studies suggest that due to the current economic and political state, we will experience an increase in domestic supply (Russian Domestic Supply of Farm Inputs Will Rise, 2023; Tikhomirova, 2023).

Self-sufficiency levels in vegetable and fruit cultivation remain critically low, at 88.5% and 47.3%, respectively, in 2022. These results agree with the study of Eliseev and Martynenko (2024). The gradual increase in fruit sufficiency indicates a growing potential and a need for more research into creating optimal conditions for fruit crops to thrive. Our study reveals a dual dependency in agricultural machinery: while 70-96% of grain and forage harvesters are domestically produced, imports dominate sectors like sugar beet harvesters (99%) and livestock machinery (90%). These findings are consistent with Reddy *et al.* (2022), who attributed this over dependency on high-tech machinery among domestic farmers. The increased reliance on Chinese machinery post-2014 sanctions, noted by Zhilkin and Grigoryev (2023), underscores the critical role of international partnerships in mitigating these gaps.

The Russian government's import substitution policies have shown mixed results across agricultural sectors. Positive outcomes are evident in grain, meat, and poultry production, where substantial investments in infrastructure and subsidies have encouraged self-sufficiency. Technological advancement and locally produced agricultural machinery will go a long way to reduce import dependence and, in successful cases, increase export rates.

While the current study provides a comprehensive analysis of import dependencies, its scope is limited by the lack of granular data on emerging technologies and niche markets such as vertical farms and digitalization (Popkova, 2022) or the rising roles of organic farming (Nesterenko *et al.*, 2020). Future research should focus on these dimensions, alongside an in-depth examination of regional disparities within Russia's agricultural sector. Future studies could explore pathways to integrate localized IT solutions, precision farming, artificial intelligence, and deep learning models, drawing insights from global examples.

In conclusion, this study reaffirms the critical role of strategic investments and policy interventions in reducing import dependency in Russia's agro-sector. By addressing structural and technological gaps, fostering innovation, and adopting

innovative practices, Russia can achieve greater resilience and sustainability in its agro-industrial complex.

***Conclusion*:** In conclusion, this study provides a comprehensive analysis of the current state of the Russian agricultural sector, highlighting its dependency on imports and the efforts to reduce this reliance under the pressure of international sanctions. While Russia has made progress in self-sufficiency in key areas such as grain, vegetable oil, fish, and sugar production, several sectors remain critically import-dependent, notably the production of fruits and berries, as well as vegetables. Our study emphasizes that while import substitution policies have shown progress in decreasing dependency in some areas, challenges persist in sectors reliant on advanced technologies and genetic materials. The agricultural machinery sector, particularly in specialized equipment like sugar beet harvesters, remains dependent on external supply.It is imperative that the Russian government prioritize technological advancements to bridge the critical gap in science and engineering, continued investments in sector-specific policies, the development of local alternatives for key agricultural inputs and support for domestic manufacturers. Statistically, in segments dominated by Russian equipment, up to 30% of foreign machinery indicates specific niches where domestic manufacturers cannot provide the required quality and technologies or meet the full demand of the domestic market. Ultimately, strengthening Russia's agricultural independence requires a diverse approach that combines domestic innovation with strategic investments to ensure long-term sustainability and food security**.**

***Conflict of interest*:** The authors declare no conflicts of interest related to this report.

***CRediT author statement*:** Mikhail Tolmachev wrote this article, Aleksandr Tsypin has contributed to the development of the concept and data collection, Elena Gerasimova analyzed data; Aleksey Boldyrev, Zhanna Kevorkova contributed to the methodology, Taisiya Krishtaleva was engaged in processing of the results. All authors made equal contribution to this article.

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***Consent for publication*:** All authors have read and approved the final manuscript for publication.

***SDG's addressed*:** Responsible Consumption and Production.

***Policy referred*:** Russia's Food Import Substitution Policy (implemented in 2014).

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